MOBILE RADIO

MAINTENANCE MANUAL

138—174 MHz OSCILLATOR/MULTIPLIER BOARD

19D42324IG1-G4

TABLE OF CONTENTS

DESCRIPTION

The MASTR® II oscillator-multiplier can be equipped with up to eight Integrated Circuit Oscillator Modules (ICOMs). The ICOM crystal frequencies range from approximately 14 to 18 megahertz, & the crystal frequency is multiplied nine times and then amplified to provide a low side injection frequency to the mixer. An optional modification kit is available for high side injection.

In receivers equipped with a Dual Front End (DFE), a second OSC/mult board is used. A total of eight ICOMs can be used between the two OSC/mult boards.

CIRCUIT ANALYSIS

ICOMs

Three different types of ICOMs are available for use in the Osc/Mult module. Each contains a crystal-controlled Colpitts oscillator, and two of the ICOMs contain compensator ICs. The different ICOMs are:

- 5C-ICOM - contains an oscillator and a 5 part-per-million (±0.0005%) compensator IC. Provides compensation for EC-ICOMs.
- EC-ICOM - contains an oscillator only. Requires external compensation from a 5C-ICOM.
- 2C-ICOM - contains an oscillator and a 2 PPM (±0.0002%) compensator IC. Will not provide compensation for an EC-ICOM.

The ICOMs are enclosed in an RF shielded can with the type ICOM 5C-ICOM, EC-ICOM or 2C-ICOM) printed on the top of the can. Access to the oscillator trimmer is obtained through a hole on top of the can.

Frequency selection is accomplished by switching the ICOM keying lead (terminal 6) to A- by using the frequency selector switch on the control unit. In single frequency radios, a jumper from H9 to H10 in the control unit connects terminal 6 of the ICOM to A-.

In DFE applications, keying leads of the receiver and the DFE osc/mult ICOMs are operated in parallel. Therefore, ICOMs in the receiver can not be placed in the same position as those in the DFE.

In the receive mode, +10 Volts is applied to the external ICOM load resistor (R401) by the RX Osc control line, keeping the selected ICOM turned on. Keying the transmitter removes the 10 Volts at R401, turning the ICOM off.

CAUTION

All ICOMs are individually compensated at the factory and cannot be repaired in the field. Any attempt to repair or change an ICOM frequency will void the warranty.

In standard 5 PPM radios using EC-ICOMs, at least one 5C-ICOM must be used. The 5C-ICOM is normally used in the receiver F1 position, but can be used in any transmit or receive position. One 5C-ICOM can provide compensation for up to 15 EC-ICOMs in the transmitter and receiver. Should the 5C-ICOM compensator fail in the open mode, the EC-ICOMs will still maintain 2 PPM frequency stability from 0°C to 55°C (+32°F to 131°F) due to the regulated compensation voltage (+5 Volts) from the 10-Volt regulator IC. If desired, up to 16 5C-ICOMs may be used in the radio.

The 2C-ICOMs are self-compensated to 2 PPM and can not provide compensation for EC-ICOMs.

When a DFE is used with a wide spaced transmitter option, compensation voltage for the 5C-ICOMs is supplied from the +10 Volt regulator IC provided with the wide spaced transmitter option.

Oscillator Circuit

The quartz crystals used in ICOMs exhibit the traditional "S" curve characteristics of output frequency versus operating temperature.

At both the coldest and the hottest temperatures, the frequency increases with increasing temperature. In the middle temperature range (approximately 0°C to +55°C), frequency decreases with increasing temperature. In the middle temperature range (approximately 0°C to +55°C), frequency decreases with increasing temperature.

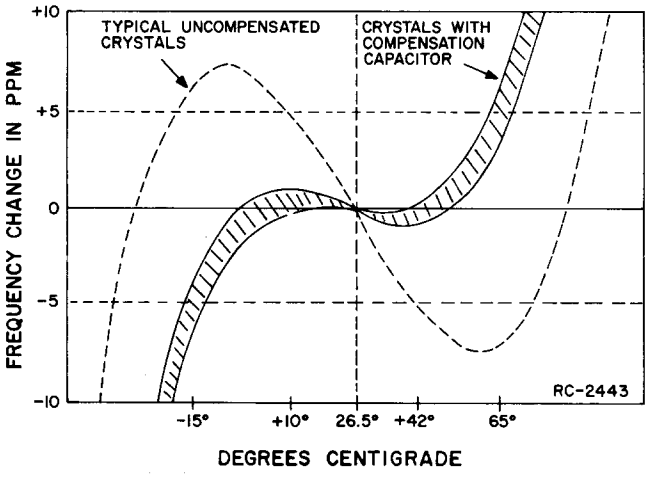


Figure 1 - Typical Crystal Characteristics

Since the rate of change is nearly linear over the mid-temperature range the output frequency change can be compensated by choosing a parallel compensation capacitor with a temperature coefficient approximately equal and opposite that of the crystal.

Figure 1 shows the typical performance of an uncompensated crystal as well as the typical performance of a crystal which has been matched with a properly chosen compensation capacitor.

At temperatures above and below the mid-range, additional compensation must be introduced. An externally generated compensation voltage is applied to a varactor (voltage-variable capacitor) which is parallel with the crystal.

A constant bias of 5 Volts (provided from Regulator IC U901 in parallel with the compensator) establishes the varactor capacity at a constant value over the entire mid-temperature range. With no additional compensation, all of the oscillators will provide 2 PPM frequency stability from 0°C to 55°C (+30°F to 131°F).

Compensator Circuits

Both the 5C-ICOMs and 2C-ICOMs are temperature compensated at both ends of the temperature range to provide instant frequency compensation. An equivalent ICOM circuit is shown in Figure 2.

The cold end compensation circuit does not operate at temperatures above 0°C. When the temperature drops below 0°C. When the temperature drops below 0°C, the circuit is activated. As the temperature decreases, the equivalent resistance decreases and the compensation voltage increases.

The increase in compensation voltage decreases the capacity of the varactor in the oscillator, increasing the output frequency of the ICOM.

The hot end compensation circuit does not operate at temperatures below +55°C. When the temperature rises above +55°C, the circuit is activated. As the temperature increases, the equivalent resistance decreases and the compensation voltage decreases. The decrease in compensation voltage increases the capacity of the varactor, decreasing the output frequency of the ICOM.

Service Note: Proper ICOM operation is dependent on the closely-controlled input voltages from the 10-Volt regulator. Should all of the ICOMs shift off frequency, check the 10-Volt regulator module.

MULTIPLIER & AMPLIFIER

The output of the selected ICOM is coupled through a tuned circuit (L401 and C406) that is tuned to three times the crystal frequency. The output of the tuned circuit is applied to the base of Class C multiplier, Q401. The collector tank circuit of the multiplier (L402, C411 and C412) is tuned to nine times the crystal frequency. The output of the multiplier stage is metered across R402 and applied to receiver metering jack J601 through P903-14.

Following the multiplier is a Class A Amplifier stage, Q402. The output of Q402 is metered through a metering network consisting of C419, C420, CR402 and R407 and applied to receiver metering jack J601 through P903-15. The amplified output of Q402 is applied to a tuned circuit (L403 and C416) that is tuned to nine times the crystal frequency. The tuned circuit provides some selectivity in the oscillator-multiplier chain.

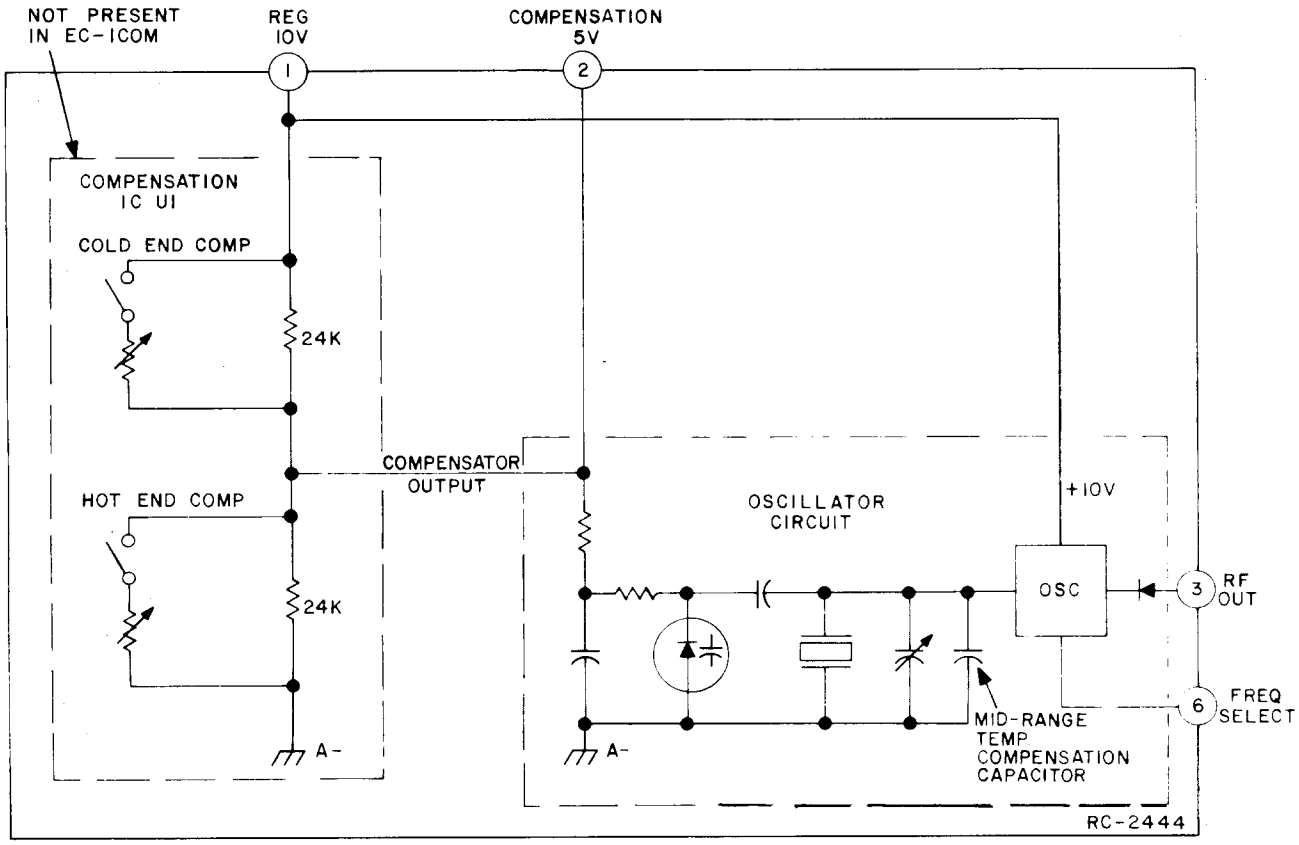
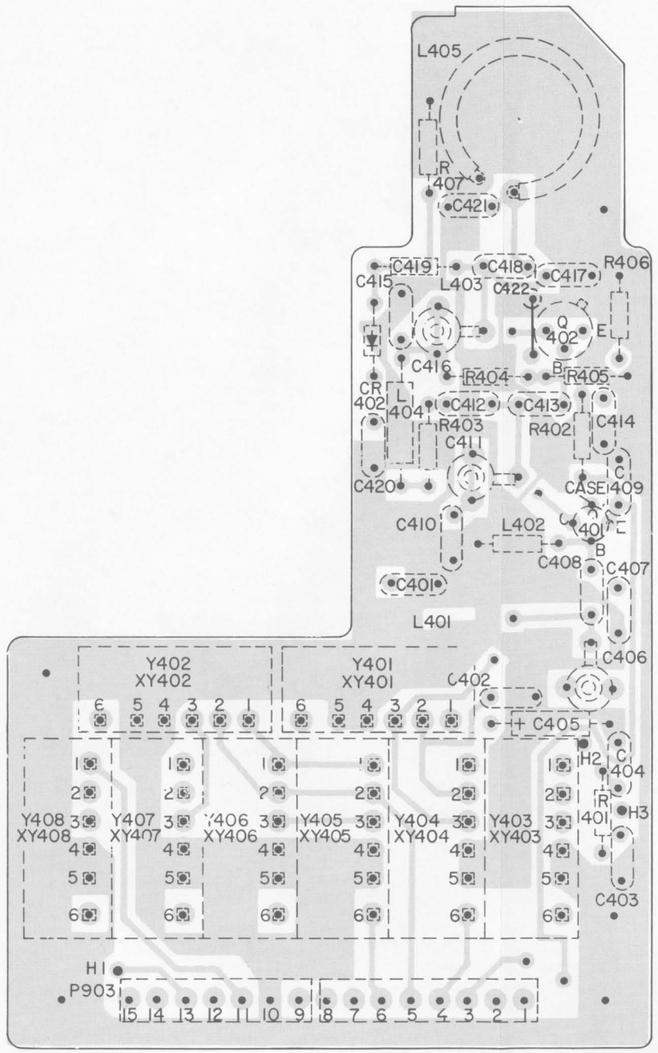


Figure 2 - Equivalent ICOM Circuit

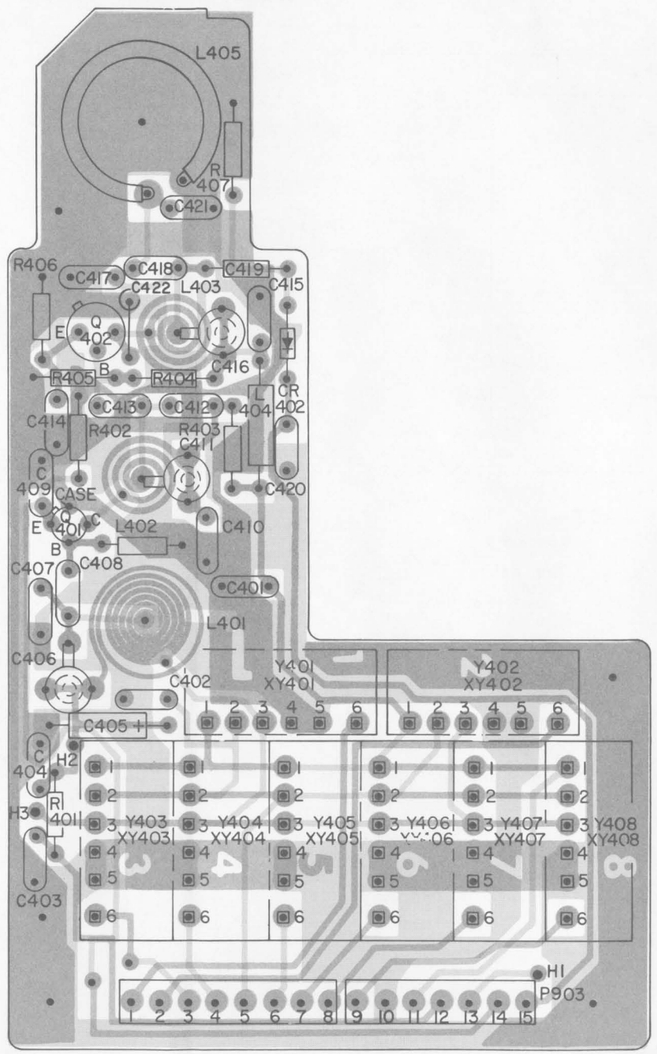
The output of the oscillator/multiplier board is inductively coupled through L405 and two helical resonators on the RF assembly to the input of the mixer stage.

SOLDER SIDE



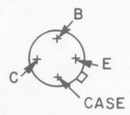
(19D423242, Sh. 2, Rev. 1)

COMPONENT SIDE



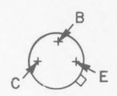
(19D423242, Sh. 2, Rev. 1)
(19D423242, Sh. 3, Rev. 1)

LEAD IDENTIFICATION FOR Q401



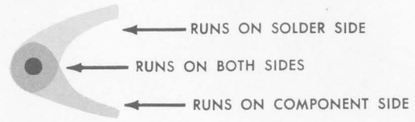
VIEW FROM CASE END

LEAD IDENTIFICATION FOR Q402



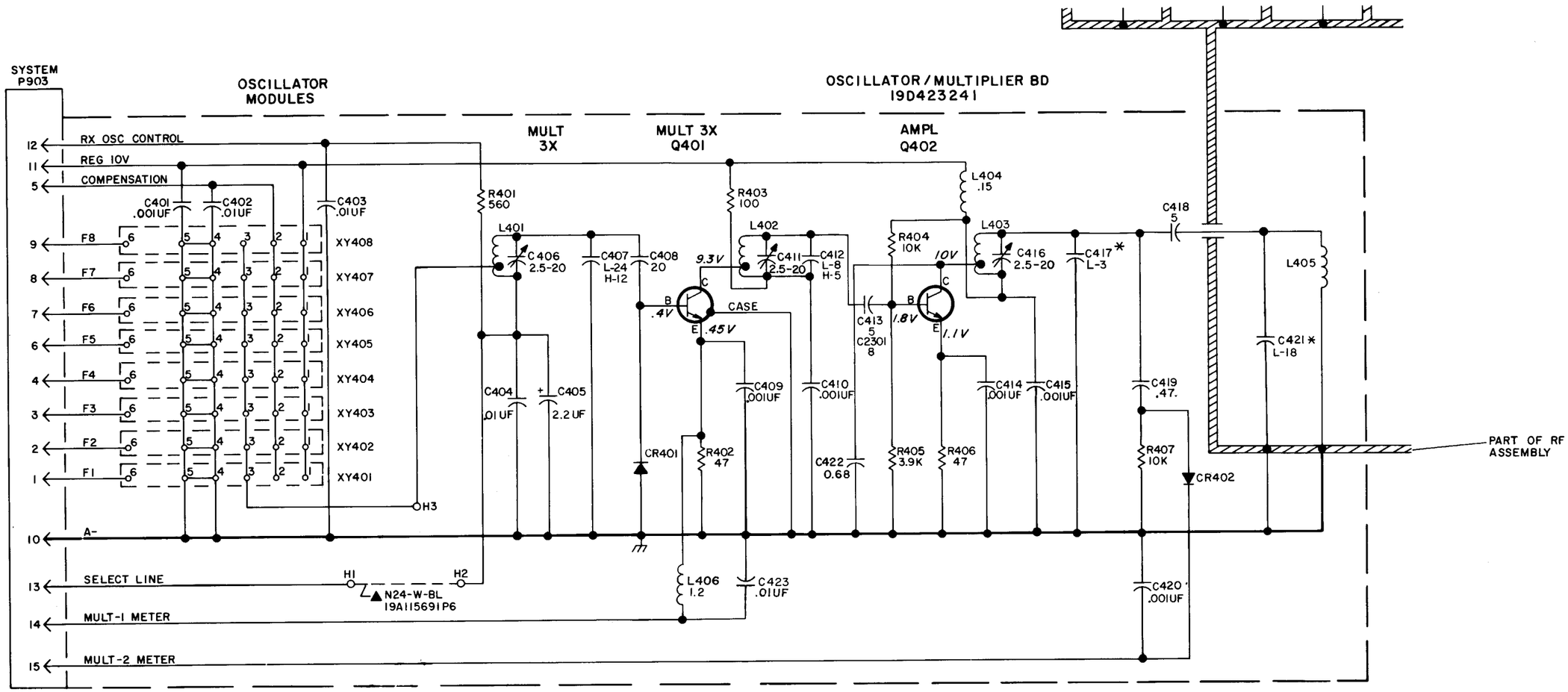
VIEW FROM CASE END

(19D423587, Rev. 1)



OUTLINE DIAGRAM

138—174 MHz OSCILLATOR/MULTIPLIER
19D423241G1-G4



(19D423488, Rev. 6)

▲THESE COMPONENTS ARE USED TO ADAPT A STANDARD MASTR II RECEIVER TO OPERATION AS AND WITH A DUAL FRONT END. THESE COMPONENTS SHOULD BE IGNORED IN THE STANDARD RECEIVER. BOARDS IDENTIFIED BY A RED DOT HAVE BEEN MODIFIED FOR DFE OPERATION PER MOD KIT 19A129750G1 OR G2.	
RECEIVER CHANNEL	D. F. E. CHANNEL
SEE MIXER/IF BOARD FOR OTHER DFE CHANGES	NO MODIFICATION REQUIRED ON THE MIXER/IF BOARD
THESE ITEMS ARE SUPPLIED IN MOD. KIT PL19A129750G1	ON PL19D423241 (OSC/MULT BD)
	1. N24-W-BL JUMPER ADDED BETWEEN H1 & H2 ON OSC/MULT BD.
	THESE ITEMS ARE SUPPLIED IN MOD. KIT PL19A129750G2.
ON PL19D423241 (OSCILLATOR/MULTIPLIER BOARD); REPLACE C413 (5PF) WITH C2301 (8PF) CAPACITOR. THESE ITEMS ARE SUPPLIED IN MODIFICATION KIT PL19A129750G1.	

	REV LETTER	FREQ RANGE (MHZ)	NO. OF FREQ
OSC/MULT BD			
19D423241G1	B	138-155	2
19D423241G2	C	150.8-174	2
19D423241G3	B	138-155	8
19D423241G4	C	150.8-174	8

VOLTAGE READINGS

VOLTAGE READINGS ARE TYPICAL READINGS MEASURED TO SYSTEM NEGATIVE (P903-10) WITH TEST SET MODEL 4EX3A11 OR A 20,000 OHM-PER-VOLT METER.

⏥ INDICATES A-

⏚ INDICATES VEHICLE GROUND

* C417 USED IN GROUPS 1 & 3 ONLY.

ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED AND RESISTOR VALUES IN OHMS UNLESS FOLLOWED BY K=1000 OHMS OR MEG=1,000,000 OHMS. CAPACITOR VALUES IN PICOFARADS (EQUAL TO MICROMICROFARADS) UNLESS FOLLOWED BY UF=MICROFARADS. INDUCTANCE VALUES IN MICROHENRYS UNLESS FOLLOWED BY MH=MILLIHENRYS OR H=HENRYS.

IN ORDER TO RETAIN RATED EQUIPMENT PERFORMANCE, REPLACEMENT OF ANY SERVICE PART SHOULD BE MADE ONLY WITH A COMPONENT HAVING THE SPECIFICATIONS SHOWN ON THE PARTS LIST FOR THAT PART.

SCHEMATIC DIAGRAM

138—174 MHz OSCILLATOR/MULTIPLIER
19D423241G1-G4

PARTS LIST

LBI4985D

138-174 MHz OSCILLATOR/MULTIPLIER
19D423241G1 138-155 MHz 2 FREQ (L)
19D423241G2 150.8-174 MHz 2 FREQ (H)
19D423241G3 138-155 MHz 8 FREQ (L)
19D423241G4 150.8-174 MHz 8 FREQ (H)

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C401	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C402 thru C404	19A116080P101	Polyester: 0.01 µf ±10%, 50 VDCW.
C405	5496267P13	Tantalum: 2.2 µf ±20%, 20 VDCW; sim to Sprague Type 150D.
C406	19B209351P2	Variable, ceramic: 2.5 to 20 pf, 200 VDCW, temp coef -250 +700 PPM/°C; sim to Matshushita ECV-1Z-W20P32.
C407L	19A116656P24J8	Ceramic disc: 24 pf ±5%, 500 VDCW, temp coef -80 PPM.
C407H*	19A116656P12J8	Ceramic disc: 12 pf ±5%, 500 VDCW, temp coef -80 PPM. In REV B and earlier:
	19A116656P18J8	Ceramic disc: 18 pf ±5%, 500 VDCW, temp coef -80 PPM.
C408	19A116656P20K0	Ceramic disc: 20 pf ±10%, 500 VDCW, temp coef 0 PPM.
C409 and C410	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C411	19B209351P2	Variable, ceramic: 2.5 to 20 pf, 200 VDCW, temp coef -250 +700 PPM/°C; sim to Matshushita ECV-1ZW20P32.
C412L	19A116656P8J0	Ceramic disc: 8 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C412H	19A116656P5J0	Ceramic disc: 5 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C413	19A116656P5K0	Ceramic disc: 5 pf ±1 pf, 500 VDCW, temp coef 0 PPM.
C414 and C415	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C416	19B209351P2	Variable, ceramic: 2.5 to 20 pf, 200 VDCW, temp coef -250 +700 PPM/°C; sim to Matshushita ECV-1ZW20P32.
C417L	19A116656P3J0	Ceramic disc: 3 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C418	19A116656P5J0	Ceramic disc: 5 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C419	5491601P13	Phenolic: 0.47 pf ±10%, 500 VDCW.
C420	19A116655P19	Ceramic disc: 1000 pf ±20%, 1000 VDCW; sim to RMC Type JF Discap.
C421L	19A116656P18K1	Ceramic disc: 18 pf ±10%, 500 VDCW, temp coef -150 PPM.
C422*	5491601P117	Phenolic: 0.68 pf ±5%, 500 VDCW. Added by REV A.
C423*	19A116080P101	Polyester: 0.01 µf ±10%, 50 VDCW. Added by REV B.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR401	19A115250P1	Silicon, fast recovery, 225 MA, 50 PIV.
CR402	19A116052P5	Silicon.
		- - - - - - - - - - INDUCTORS - - - - - - - - - -
L401 thru L403		(Part of printed board 19D424562P1).
L404	7488079P1	Choke, RF: 0.15 µh ±20%, 0.03 ohms DC res max; sim to Jeffers 4411-1M.
L405	19A129280P1	Coil.
L406*	19B209420P114	Coil, RF: 1.20 µh ±10%, 0.18 ohms DC res max; sim to Jeffers 4436-1K. Added by REV B.

SYMBOL	GE PART NO.	DESCRIPTION
		- - - - - - - - - - PLUGS - - - - - - - - - -
P903		Connector. Includes:
	19B219594P1	Contact, electrical: 7 pins.
	19B219594P2	Contact, electrical: 8 pins.
		- - - - - - - - - - TRANSISTORS - - - - - - - - - -
Q401	19A115440P1	Silicon, NPN.
Q402	19A115329P2	Silicon, NPN.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R401	3R152P561K	Composition: 560 ohms ±10%, 1/4 w.
R402	3R152P470K	Composition: 47 ohms ±10%, 1/4 w.
R403	3R152P101K	Composition: 100 ohms ±10%, 1/4 w.
R404	3R152P103K	Composition: 10K ohms ±10%, 1/4 w.
R405	3R152P392K	Composition: 3.9K ohms ±10%, 1/4 w.
R406	3R152P470K	Composition: 47 ohms ±10%, 1/4 w.
R407	3R152P103K	Composition: 10K ohms ±10%, 1/4 w.
		- - - - - - - - - - SOCKETS - - - - - - - - - -
XY401 thru XY408	19A116779P1	Contact, electrical: sim to Molex 08-50-0404.
		- - - - - - - - - - OSCILLATORS - - - - - - - - - -
		NOTE: When reordering specify ICOM Frequency. For Standard Low Side Injection Freq.
		ICOM Freq = Operating Freq - 11.2 / 9
Y401 thru Y408	19A129393G11	Compensated: ±5 PPM, 138-174 MHz.
	19A129393G7	Externally Compensated: ±5 PPM, 138-174 MHz.
	19A129393G3	Compensated: ±2 PPM, 138-174 MHz.
		NOTE: For High Side Injection Freq Using High Side Modification Kit 19A130045G1.
		ICOM Freq = Operating Freq + 11.2 / 9
Y401 thru Y408	19A130283G5	Compensated: ±5 PPM, 138-174 MHz.
	19A130283G3	Externally Compensated: ±5 PPM, 138-174 MHz.
	19A130283G1	Compensated: ±2 PPM, 138-174 MHz.
		- - - - - - - - - MISCELLANEOUS - - - - - - - - -
	4036555P1	Insulator, washer: nylon. (Used with Q402).
	4031594P1	Insulator. (Used with C406, C411, C416).
		HIGH SIDE INJECTION MODIFICATION KIT 19A130045G2
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C2311	19A116656P12K0	Ceramic disc: 12 pf ±10%, 500 VDCW, temp coef 0 PPM.
C2312	19A116656P3J0	Ceramic disc: 3 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C2313	19A116656P5J0	Ceramic disc: 5 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
C2314	19A116656P4J0	Ceramic disc: 4 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
		- - - - - - - - - - MISCELLANEOUS - - - - - - - - -
	19A130028P1	Spacer: 1/8 inch long.
	19A130028P2	Spacer: 3/4 inch long.
	19A130029P1	Washer: brass.

SYMBOL	GE PART NO.	DESCRIPTION
		MODIFICATION KIT 19A129750G1 RECEIVER 19A129750G2 DFE
		- - - - - - - - - - CAPACITORS - - - - - - - - - -
C2301	19A116656P8J0	Ceramic disc: 8 pf ±0.5 pf, 500 VDCW, temp coef 0 PPM.
		- - - - - - - DIODES AND RECTIFIERS - - - - - - -
CR2301	19A116925P1	Silicon.
		- - - - - - - - - - RESISTORS - - - - - - - - - -
R2301	3R152P223J	Composition: 22K ohms ±5%, 1/4 w.
R2302	3R152P681K	Composition: 680 ohms ±10%, 1/4 w.
R2303	3R152P911J	Composition: 910 ohms ±5%, 1/4 w.
		- - - - - - - - - - CABLES - - - - - - - - - -
W2301	19B219999G2	Cable: approx 10-1/2 inches long.

PRODUCTION CHANGES

Changes in the equipment to improve performance or to simplify circuits are identified by a "Revision Letter", which is stamped after the model number of the unit. The revision stamped on the unit includes all previous revisions. Refer to the Parts List for descriptions of parts affected by these revisions.

REV. A - Oscillator/Multiplier Board 19D423241G1-4
To prevent oscillation. Added C422.

REV. B - To decrease possibility of radiation from Mult-1 meter lead. Added C423 and L406.

REV. C - Oscillator/Multiplier 19D423241G2, 4

To improve tuning. Changed C407H.

*COMPONENTS ADDED, DELETED OR CHANGED BY PRODUCTION CHANGES